

Education

2020 – 2024 **Indian Institute of Technology Bombay**, India
Bachelor of Technology in Engineering Physics, Grade: **8.82/10**
With a Minor in Electrical Engineering
Standardized Tests: GRE Physics: **990/990** (96th percentile)
TOEFL: **115/120**

Publications

- **Mehla A.**, Kasliwal, M. M. et al. "Oxygen Isotope Ratios in Hydrogen-Deficient Carbon Stars: A Correlation with Effective Temperature and Implications for White Dwarf Merger Outcomes". *Manuscript in prep.* (2024)
- Bala S., Mate S., **Mehla A.** et al., "Prospects of measuring gamma-ray burst polarization with the Daksha mission". *J. Astron. Telesc. Instrum. Syst.* 9(4) 048002 (2023)
- Bhalerao V., Sawant D., ... , **Mehla A.** et al. "Science with the Daksha High Energy Transients Mission". *Exp Astron* 57, 23 (2024) (2024)

Conference Proceedings

- **Mehla A.**, Dewangan G. et al. "All-sky Compton Imaging with the Daksha space mission", Poster presented at *ASI 2024 Annual Meeting*, IISc Bangalore (2024)
- Mate S., Sastry P., **Mehla A.** et al. "Hard X-ray Polarization measurement capability of Daksha", Poster presented at *Astrophysical Polarimetry in the Time-Domain Era*, Politecnico di Milano, Italy (2022)

Research Experience

- July 2024 – Present **Oxygen Isotope Ratios of Hydrogen-deficient Carbon (HdC) Stars**
Guides: Prof. Mansi Kasliwal (Caltech), Dr. Patrick Tisserand (Institut d'Astrophysique de Paris)
- Reduced high-resolution K -band spectra of a sample of R Coronae Borealis (RCB) and dustless HdC (dLHdC) stars acquired using IRTF/iSHELL
 - Developed a semi-automated fitting routine to obtain robust estimates of CNO abundances and the $^{16}\text{O}/^{18}\text{O}$ ratio using spectral synthesis with Turbospectrum, confirming that dLHdCs have significantly lower ratios than RCBs
 - Discovered a trend of decreasing $^{16}\text{O}/^{18}\text{O}$ ratios with increasing effective temperatures, confirming predictions of white dwarf merger models for the first time
 - Discovered a strong correlation between the abundances of ^{18}O and ^{14}N , implying roughly 1% of the original ^{14}N is converted to ^{18}O via α -capture across all stars
- July 2024 – Present **A Synthetic Catalogue for Photometric Calibration of Cryoscope observations**
Guide: Prof. Mansi Kasliwal (Caltech)
- Fitted existing photometric data from a variety of surveys to stellar models in order to extract spectral energy distributions that can predict flux in the K_{dark} band
 - Studied the effectiveness of this method by comparing these synthetic fluxes with those generated from spectral libraries from IRTF and X-Shooter
 - Synthesized a catalogue of stars with synthetic K_{dark} magnitudes to be used for photometric calibration of the Cryoscope instrument

- May 2023 – **Demonstrating Optimal Nonlinear Control in a Classical Experiment**
 Aug 2023 Guide: Prof. Rana Adhikari, California Institute of Technology (LIGO-SURF Fellowship)
- Designed and constructed low-noise analog circuits for temperature readout and pulse-width modulation (PWM) driven heater circuits for the control system
 - Implemented a Raspberry Pi-based controller including data acquisition and actuation systems using a WaveShare AD/DA Board
 - Created numerical models to simulate heat-transfer mechanisms for an insulated mass, and experimentally constrained free parameters
 - Executed PID temperature control of a system and achieved simulated performance
- Nov 2021 – **Measuring the Polarization of Gamma-Ray Bursts with the Daksha mission**
 May 2023 Guides: Prof. Varun Bhalerao (IIT Bombay), Prof. Shriharsh Tendulkar (TIFR Mumbai)
- Simulated the interactions of high-energy photons with the satellite mass model and detector readout using the GEANT4 toolkit to obtain realistic event files
 - Obtained the background rates due to Cosmic X-ray Background and Earth albedo
 - Developed a processing pipeline to implement Compton polarimetry with pixelated CdZnTe detectors using a χ^2 fitting-based template matching technique
 - Determined the Minimum Detectable Polarization (MDP) of the mission through a novel Monte Carlo sampling method, estimating the detection rate for polarized GRBs
- Aug 2023 – **All-sky Compton Imaging with the Daksha space mission**
 May 2024 Guide: Prof. Gulab Dewangan, Inter-University Centre for Astronomy and Astrophysics
- Integrated NaI scintillators into the mass model and emulated SiPM readout to generate realistic data with Poissonian timestamps and effects of spatial and energy resolution
 - Implemented a Compton reconstruction algorithm to utilize coincident events between detector pairs and effectively localize sources in the sky and project them with HealPy
 - Analyzed simulated data in the Compton Data Space to estimate the angular resolution and sensitivity of the mission for various source types and intensities

Awards and Achievements

- Among the **top 23** students worldwide to be awarded a fully-funded LIGO-SURF summer internship at the California Institute of Technology (2023)
- Awarded the MITACS Globalink Research Award for a summer internship at TRIUMF, Vancouver and the ANU Future Research Talent Award (both declined) (2023)
- Bestowed the Undergraduate Research Award by the Department of Physics, IIT Bombay for performing exceptional research (2023)
- Awarded a Branch Change to Engineering Physics on the basis of exemplary academic performance (2021)
- Ranked **959th** nationwide among **1 million** candidates in the JEE Main exam (2020)
- Among the **top 450** students nationally selected for Indian National Physics Olympiad (INPhO), the second stage of qualifiers to the International Physics Olympiad (2019)
- Awarded the prestigious KVPY Fellowship by the Department of Science and Technology, Government of India twice with nationwide ranks of **466** and **306** (2018, 2019)

Workshops

- December 2022 **Radio Astronomy Winter School, NCRA-TIFR Pune**
 Ten-day offline school consisting of talks and experiments on the fundamentals of radio astronomy
- Attended seminars by renowned experts on topics like radiative processes, techniques and instruments used, observational radio astronomy, cosmology and fast radio bursts
 - Recorded observations of HI emissions at different longitudes in the galactic plane with a horn antenna and obtained a rotation curve for the Milky Way using redshifts

- December 2022 **GEANT4 and its Application to High-Energy Physics & Astrophysics, IUCAA Pune**
Five-day offline workshop on the applications of GEANT4 intended for graduate students
- Attended talks by prominent researchers working on various experiments like CMS, Hyper-K, POLAR, Fermi and AstroSat, learnt about the simulation techniques utilized
 - Implemented detector systems like CMS-HGCAL and a scattering polarimeter from scratch during hands-on tutorials and analyzed resulting data using Python and ROOT

Other Projects

- Spring 2023 **Studying an Exoplanetary System with GROWTH-India Telescope (Report)**
Guide: Prof. Varun Bhalerao, IIT Bombay (Course: Observational Astrophysics)
- Submitted a proposal to observe a transit of exoplanet WASP-43b around its host star
 - Reduced images to compute the relative flux evolution using Astropy and Photutils
 - Fitted the observed transit data to a model using a Markov-Chain Monte Carlo method with the exoplanet package and inferred several parameters within 1σ of actual values
- Autumn 2022 **Resonant Mass GW Detectors : Instrumentation & Noise Sources (Report)**
Guide: Prof. Archana Pai, IIT Bombay (Course: Gravitational Wave Astronomy & Physics)
- Surveyed literature on the mechanics of resonant bar gravitational wave detectors, noise sources, measurement challenges involved and limitations of the technique
 - Analyzed the electro-mechanical oscillator system and its transfer function to understand its advantages for the detection of gravitational waves
 - Quantified the minimal detectable energy and noise spectral density of noise sources
- May 2021 – June 2022 **IIT Bombay Student Satellite Program**
Communication Subsystem, GLEE Project
- Designed a prototype PCB ChipSat capable of processing and wirelessly transmitting data from the lunar environment gathered by two sensors interfaced with a microcontroller
 - Implemented UART and SPI communication protocols to achieve data transmission
- Instrumentation Subsystem, GLEE Project**
- Scrutinized components for and constructed a multi-stage analog readout circuit for a PIN diode based spectroscope to study solar flares on the lunar surface
 - Verified the functioning of the circuit by injecting simulated input signals
- Autumn 2023 **Speckle Imaging and Adaptive Optics**
Guide: Prof. Archana Pai, IIT Bombay (Course: Advanced Astrophysics)
- Discussed the method of speckle interferometry using Fourier transforms to obtain the power spectrum of the source, and demonstrated the technique with SOAR HRCam data
 - Studied the working of adaptive optics systems and Shack-Hartmann wavefront sensors
 - Discussed key results from each technique, and compared their advantages and limitations
- July 2021 – Sept 2021 **Simulating Asteroid Belt Dynamics**
Summer Project, Kritika: The Astronomy Club of IIT Bombay
- Implemented a Monte Carlo simulation to evolve large distributions of asteroids over millions of years to observe the emergence of features like Kirkwood gaps and Trojans
 - Optimised simulation times by a factor of 6 to 12 via implementation of parallelized code using high performance computing libraries like OpenMP and CUDA Fortran
- Autumn 2022 **Truly Random Number Generator using Chaos**
Guide: Prof. Pradeep Sarin (Course: Microcontroller Lab)
- Designed and built a chaotic Chua circuit tuned to operate in the double scroll region
 - Interfaced the circuit with an Arduino and pre-processed the bitstream using the von Neumann whitening algorithm to de-skew them, proved randomness using rigorous tests

Autumn 2021 **Closed Loop Analog LED Controller**

Guide: Prof. Pradeep Sarin (Course: Op-amp Lab)

- Designed a P-Type Controller with a photodiode as input to maintain the intensity of an LED at a constant set-point in the presence of ambient noise
- Debugged and tuned the circuit parameters after implementing it on a breadboard using several operational amplifiers to achieve stable behaviour

Technical Skills

Languages Python, C/C++, Fortran, MATLAB, \LaTeX , Embedded C

Packages Astropy, HealPy, Photutils, NumPy, Matplotlib, SciPy, SymPy, Pandas, Numba, PyMC

Others Git, GEANT4, OpenMP, CUDA, ROOT, LTspice, Photoshop, EAGLE, Arduino IDE, Turbospectrum

Leadership and Teaching Experience

June 2022 – **Manager, Krittika: The Astronomy Club of IIT Bombay**

May 2023 Led a team of 15 to organize outreach and research events to propagate astronomy at IITB

- Handled a budget of INR 250k+ utilized to purchase telescopes, imaging equipment and to organize events such as trivia quizzes, visits to observatories for the student body
- Acquired approval for the development of the IIT Bombay Observatory with an initial funding of USD 25,000, spearheaded the project for two years
- Organized the Krittika Summer Projects – 10 week long mentored research projects in astronomy; received 100+ applications, international participation for the first time
- Hosted regular observing sessions with a reach of 1000+ students and staff members
- Introduced modern techniques like Electronically Assisted Astronomy to the club's arsenal

Spring 2023 **Teaching Assistant, PH 111: Introduction to Classical Physics**

- Responsible for tutoring 40 students, guiding them with coursework & solving doubts
- Ensured smooth conduction of course by acting as a point of contact between students and course instructors; graded assignments, exams and provided feedback to students

Autumn 2023 **Teaching Assistant, PH 435: Microcontroller Lab**

- Responsible for grading and assisting groups of 10+ students during weekly labs
- Advised teams for hardware projects, guided them with debugging and troubleshooting

Extracurricular Activities and Interests

- Captured several images of deep sky objects, the Milky Way and planets along with special astronomical events like comets, eclipses and meteor showers with basic equipment
- Skilled in processing raw data from professional sources like the HST, JWST; awarded **NASA APOD** for processing an image of the Trifid Nebula in 2022
- Featured multiple times on outreach pages of NASA and ESA for astrophotography
- Received a cash prize and an internship offer as sole winner out of 20+ teams in the Astronomy General Championship conducted by Nayam Innovations and IIT Bombay
- Attended the 3-day Vijyoshi Science Camp conducted at IISc Bangalore for KVPY fellows and attended talks by world-renowned researchers from various fields of science